

Visual Impairment/Increased Intracranial Pressure (VIIP): Layman's Summary

To date NASA has documented that seven long duration astronauts have experienced in-flight and post-flight changes in vision and eye anatomy including degraded distant vision, swelling of the back of the eye, and changes in the shape of the globe. We have also documented in a few of these astronauts post-flight, increases in the pressure of the fluid that surrounds the brain and spinal cord. This is referred to as increased intracranial pressure (ICP). The functional and anatomical changes have varied in severity and duration. In the post-flight time period, some individuals have experienced a return to a pre-flight level of visual function while others have experienced changes that remain significantly altered compared to pre-flight. In addition, the increased ICP also persists in the post-flight time period. Currently, the underlying cause or causes of these changes is/are unknown but the spaceflight community at NASA suspects that the shift of blood toward the head and the changes in physiology that accompany it, such as increased intracranial pressure, play a significant role.

The Space Life Sciences Directorate (SLSD) at NASA Johnson Space Center has assembled a visual impairment/increased intracranial pressure (VIIP) project team to address this issue with a comprehensive project plan addressing both operational capabilities and the development of a research plan. The operations arm of the project is addressing the implementation of medical requirements, and the immediate clinical needs of the NASA flight surgeons, such as enhanced diagnostic and treatment capabilities to respond to in-flight and post-flight diagnosis and treatment. The research arm is developing a multidisciplinary, collaborative research approach that will consist of a steering committee, a scientific advisory panel, and a research collaboration team composed of clinical, translational, and fundamental research

experts. This integrated approach is designed to effectively and efficiently address immediate clinical and operational needs while developing an interdisciplinary and collaborative research project.

NASA has determined that the first case of increased intracranial pressure with visual changes occurred in an astronaut during a long duration mission aboard the International Space Station (ISS). An astronaut reported vision changes after 3 months into a 6-month mission on ISS, necessitating use of his reading glasses when gazing at the earth. This individual experienced a degradation in distant vision during the flight, and post-flight eye exams revealed changes in the back of the eye that include swelling and tissue remodeling. Additional post-flight testing was pursued to further characterize the pathology. Findings included an above normal ICP, which suggested mild intracranial hypertension. Additional cases of altered vision have been reported since this first case and one case has included the report of a visual field defect which resulted in the astronaut having to having to tilt his or her head approximately 15 degrees to view instruments and procedures. This visual field defect persisted for over twelve months after flight. This type of functional deficit is not only of concern for the individual but is of concern to the mission and ISS program.

A change in vision during spaceflight is not a new finding; vision changes have been documented through medical testing, research, and anecdotal reports over the last 40 years. An examination of data from approximately 300 post-flight questionnaires, documented that approximately 29% of short and 60% of long duration mission astronauts report a subjective degradation in vision. Changes in vision reported by astronauts in the past were often minor, transient, and not accompanied by other symptoms or significant clinical findings. In addition,

another confounding factor is that these types of vision changes are a common finding in the general population of 40-50 year old individuals, which is the same age range as the astronauts that have experienced these changes. Due to the recently reported and documented significant functional deficits in visual acuity, the persistence of the symptoms after the mission, and the detailed anatomical images suggesting tissue changes, NASA is taking a much more aggressive approach to addressing these changes through the VIIP project.

The NASA Johnson Space Center Space Medicine Division (SD), in collaboration with the SLSD VIIP project has implemented an expanded set of medically required pre-, in-, and post-flight testing to determine the presence and degree of the changes in vision and the anatomy of the eye. In order to facilitate the in-flight collection of data, SD and VIIP have increased the on-orbit imaging capability by recently flying new devices and developing new processes to use existing equipment that can image the back of the eye, a video fundoscope; measure the pressure in the eye, a tonometer; and new procedures for the on-orbit ultrasound to characterize the inside and outside of the eye and the nerve that leads to the brain. SD and VIIP are also developing a study to evaluate a non-invasive device to measure ICP in-flight and post-flight. This increased capability and expanded set of tests will be used to inform the medical treatment of the individual astronauts as well as more comprehensively characterize changes in vision and eye anatomy. The results of these tests and images can function on an individual level to inform medical care and occupational health decisions, and on a population level inform risk management decisions. Additionally, all of these data are used in conjunction with human research data acquired over the life of the space program to determine the potential scope of the forward research plan being developed by the VIIP project.

The VIIP project is working in concert with the NASA Human Research Program (HRP) on the development of an integrated and collaborative research model. This model employs a SLSD/HRP steering committee, a scientific advisory panel (SAP) composed of internal and external experts from clinical, operational, and research backgrounds, and a collaborative research team that integrates clinical, translational, and fundamental researchers. The SLSD/HRP steering committee provides the management oversight with respect to prioritization of resources. The SAP initially assists in the determination of the scope of the research project, and over the course of the project the SAP acts as a science advisor to facilitate effective and efficient communication of scientific findings as well as recommends a course of action when research decisions have to be made. The collaborative research team will be made up of investigators willing to work collaboratively, openly communicate their work, and be flexible with their research agenda, as it will be informed by the decisions and priorities of the VIIP steering committee and the SAP.

The VIIP project will be hosting a Visual Impairment and Intracranial Pressure Summit in February 2011, in Houston, Texas. This meeting will be the first step in recruitment of individuals for the SAP and will also function as the forum in which the scope of the research problem will be defined. Post-summit activities will include the formal announcement of SAP members, documentation of the research scope, and development of the collaborative research team. Operational activities will continue as planned and documented and will be complemented by activities such as data-mining, case definition, and development of clinical practice guidelines for the treatment of spaceflight-induced visual impairment/increased intracranial pressure.